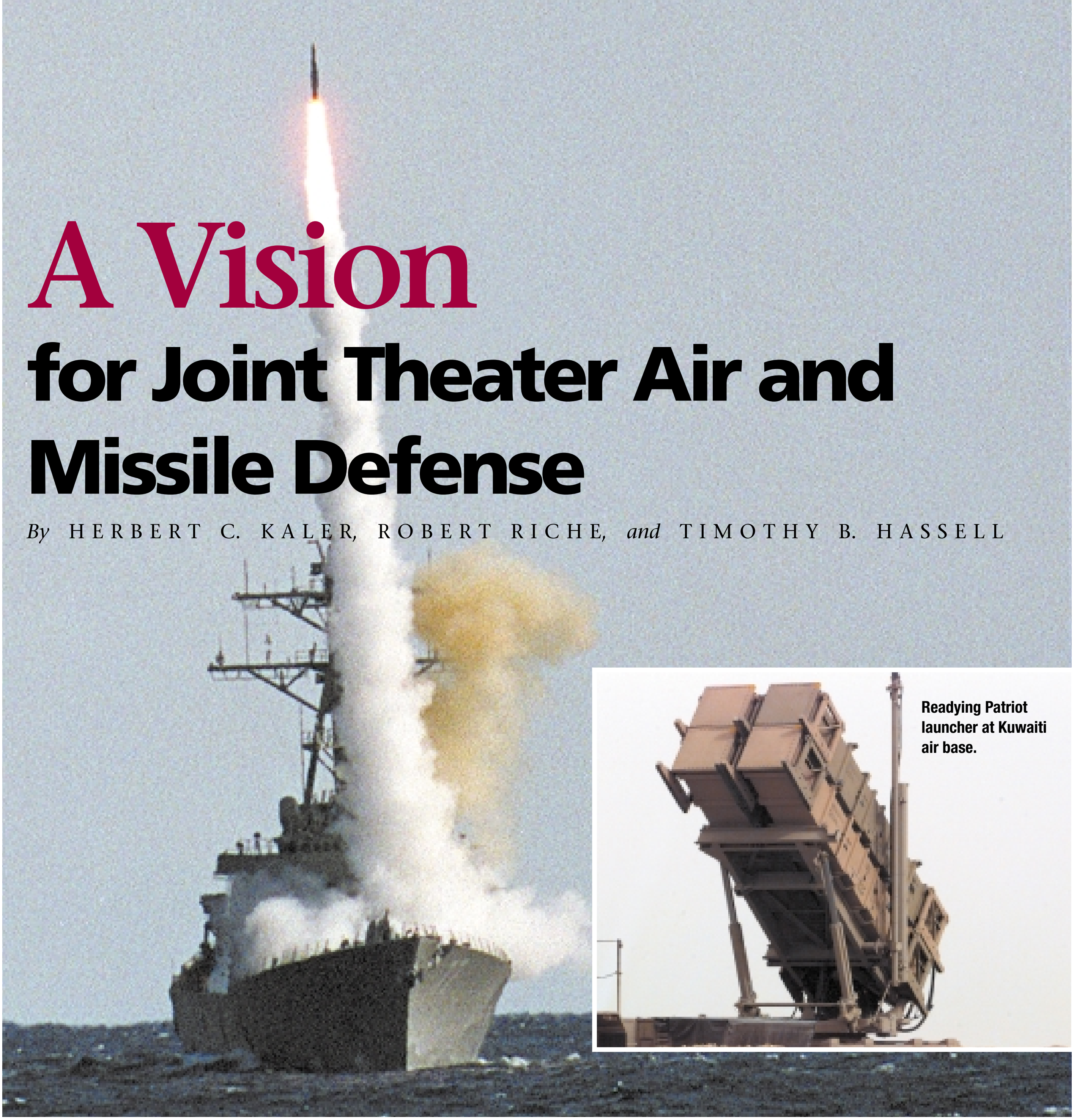
A Vision for Joint Theater Air and Missile Defense

By HERBERT C. KALER, ROBERT RICHE, *and* TIMOTHY B. HASSELL



Fleet Combat Camera, Atlantic (Phil Hartman)

USS O'Kane **test firing surface-to-air missile.**

Readying Patriot launcher at Kuwaiti air base.

1st Combat Camera Squadron (Greg L. Davis)

Joint operations will call for ever greater levels of interoperability. The need for improved interoperability to counter theater level air and missile threats will be especially acute. Cooperation between air and missile defense organizations and weapons systems features separate engagement zones and depends on coordination and procedures to reduce conflicts between systems. However, future conflicts will necessitate rapid and effective interaction among system components as well as integrated information generated by them. They will also demand that these systems operate within a coherent framework to produce capabilities for joint warfighters while capitalizing on the synergy inherent within a class of air and missile defense systems.

Even though the Persian Gulf War established clear technical and tactical superiority by the United States over enemy aircraft, the need for

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a new approach to integrated air and missile defense that embraces improved interoperability and addresses emerging threats became increasingly clear in the last decade. Deficiencies in theater ballistic missile defense architecture during Desert Storm indicated that coalition forces could not coordinate and execute adequate defense against ballistic missile threats in real time. Shortcomings in positively identifying objects flying in the battlespace have been the subject of many studies. Deficiencies in identification had tragic consequences when *USS Vincennes* shot down an Iranian commercial airliner in 1988. Positive identification proved difficult in the Gulf War, and errors contributed to another tragic incident in 1994 when Air Force interceptors shot down two Army helicopters in the Iraqi no fly zone. The Defense Science Board published a study in 1995 outlining the challenge posed by growing cruise missile capabilities and postulating how such threats could stress integrated air defenses.[1] Finally, events in the Balkans have demonstrated just how a coordinated air campaign using cruise missiles and manned aircraft operating in collaboration could disrupt sophisticated air defense capabilities.

information on detecting, tracking, and identifying targets cannot be consistently transferred among systems

Experience shows that weapons components—such as interceptors, sensors, and command and control—are not sufficiently interoperable to take advantage of their respective potential ranges and lethality. While considerable resources have been spent improving weapon range and lethality, interoperability problems that enable warfighters to employ these systems at maximum range have not been solved. Whether the causes can be attributed to technical limitations, issues of autonomy, or concern over fratricide and erroneous engagements, the practical effect is that we limit the ability of commanders to take advantage of weapons performance potential and unnecessarily constrain the time and battlespace available to support decisionmaking.

Systems Interoperability

Exacerbating the situation is the fact that information on detecting, tracking, and identifying targets cannot be consistently transferred among systems. This lost data compels the warfighter to regenerate and reiterate track and identification information. This consumes time, limits chances to engage targets early, misses opportunities for multiple target engagements, and further constrains available battlespace.

The end result is that interoperability deficiencies degrade the ability to provide warfighters with joint and integrated architectures, advanced concepts, and weapon systems for defense against theater air and missile threats. Diminished interoperability could have enormous consequences if an enemy elects to use its evolving systems to deliver weapons of mass destruction. The evidence builds a compelling case that despite major technical accomplishments in the past, air and missile defense capabilities in place today do not interoperate as effectively as they should.

As interoperability shortcomings became clear, the complexity and capability of the air and missile threat increased. The relatively short-range threat of theater ballistic missiles, like the Scud of the Persian Gulf War, is giving way to longer range missiles able to deliver payloads over great areas as evidenced by recent missile launches in Iran and North Korea. Emerging threat capabilities point toward a dangerous future.

Ballistic missile defenses will be improved enormously as new systems enter the inventory. The Patriot Advanced Capability (PAC–3), Navy Theater Wide (NTW), Theater High Altitude Area Defense (THAAD), and Airborne Laser (ABL) may limit the military utility of ballistic missiles for an enemy.[2] Land attack cruise missiles, however, are likely to appear as an alternative. The maneuverability of cruise missiles imposes increased stress on friendly air defense capabilities. They look and act like aircraft, fly close to the ground to avoid detection, and unlike ballistic missiles have no predictable trajectory. Operating in the same battlespace as the dominant air forces, cruise missiles add a confusing feature to an already complex picture of the situation. Sophisticated cruise missiles that fly very low and feature small radar cross sections present even greater challenges to defenders. The more sophisticated the missile, the more difficult it becomes to positively identify it as friendly or hostile. An enemy may view cruise missiles as a means to capitalize on U.S. concerns about fratricide and to improve an attack's chances of success.

Finally, our experiences can be a marvelous teacher for potential enemies. Recognizing the success of U.S. and NATO forces in employing integrated aircraft and cruise missile attacks in the Balkans, a future enemy may attempt to integrate its operations by using aircraft, theater ballistic, and cruise missiles to minimize effectiveness of U.S. and allied air defenses. Some estimates have discounted the ability of enemies in the near term to exercise high level planning and coordination to successfully integrate an air campaign. Given the availability of computers and planning tools, it seems at best naïve and at worst arrogantly shortsighted to think that U.S. and NATO forces

Patriot launchers departing for Southern Watch.

1st Combat Camera Squadron (James D. Mossman)

are the only ones with the wherewithal to mount such an offensive. Moreover, access to weapons of mass destruction makes the threat of even modest integrated attacks worrisome.

Operational Requirements

The service development and acquisition communities recognize emerging requirements for improved capabilities and are making considerable progress in sensor and interceptor technologies. New systems and improvements to existing systems are overcoming many technical challenges to detect and engage air and missile threats. Systems developed and fielded by service proponents are designed to meet the specifications in operational requirements documents, some of which pre-date the current understanding of joint needs and thus do not address joint interoperability. The danger is that systems may be built that are only as interoperable as stipulated in requirements documents and that fail to recognize or place value on a joint perspective.

The Joint Theater Air and Missile Defense Organization (JTAMDO) was formed in 1997 to work with the Ballistic Missile Defense Organization (BMDO), unified commanders in chief, and the services under an integrated product team process to insert a joint perspective into deliberations on future air and missile defense capability. This JTAMD process has been an important venue for examining TAMD interoperability issues and a vehicle for players across the TAMD community to identify potential solutions.

JTAMDO, in collaboration with BMDO, is charged with delivering improved, interoperable air and missile defense warfighting capabilities to CINCs. JTAMDO serves as the focal point and advocate for operational requirements and concepts while BMDO provides systems engineering and acquisition management expertise for implementing a TAMD class of systems architecture that improves interoperability and provides capabilities needed by the CINCs.

The JTAMD process is examining a range of TAMD questions. Areas under consideration include TAMD battle management C^4I, both active and passive measures to enhance air and missile defense, and operations conducted to attack air and missile threats before their use against friendly forces. The process is also exploring combat identification shortcomings, issues related to cruise missile defense, and means to address the limitations of Persian Gulf War systems against theater missile threats. The JTAMD process must eventually address questions of interoperability among U.S. air and missile defense capabilities in allied and coalition environments.

A vision of TAMD capabilities in the year 2010 has emerged from the JTAMD process and has energized a dynamic view of the future battlespace. It accommodates two major perspectives as it discusses future capability. First, it discusses the TAMD battle in terms of desired outcomes and addresses the capabilities required to attain them. Second, the vision discusses the operational conditions and environment within which the TAMD battle is likely to occur. It articulates the need to capitalize on synergy created by jointness and interoperability to produce a complete and accurate picture of the battlespace, and generate operational flexibility to meet fluid and dynamic conditions. Understanding this vision is critical for refining requirements, creating engineering solutions, and delivering capabilities to the warfighter.

a vision of TAMD capabilities in 2010 articulates the need to capitalize on synergy created by jointness and interoperability

The vision is centered on a definition of the TAMD mission area created within the JTAMD process that states activities within the mission area seek to:

> Prevent, defeat, *and* minimize *the consequences of adversary employment of ballistic, cruise, and air-to-surface missiles and aircraft, especially those equipped with weapons of mass destruction. Preventing entails destroying launchers, missiles, aircraft, and their sustaining and enabling infrastructure on the ground, or otherwise suppressing missile launchers and aircraft sorties. Defeating involves intercepting missiles and aircraft in flight to destroy their payloads. Minimizing consequences deals with warning specific personnel and areas at risk of missile and aircraft attack in time to enhance their protective posture.*

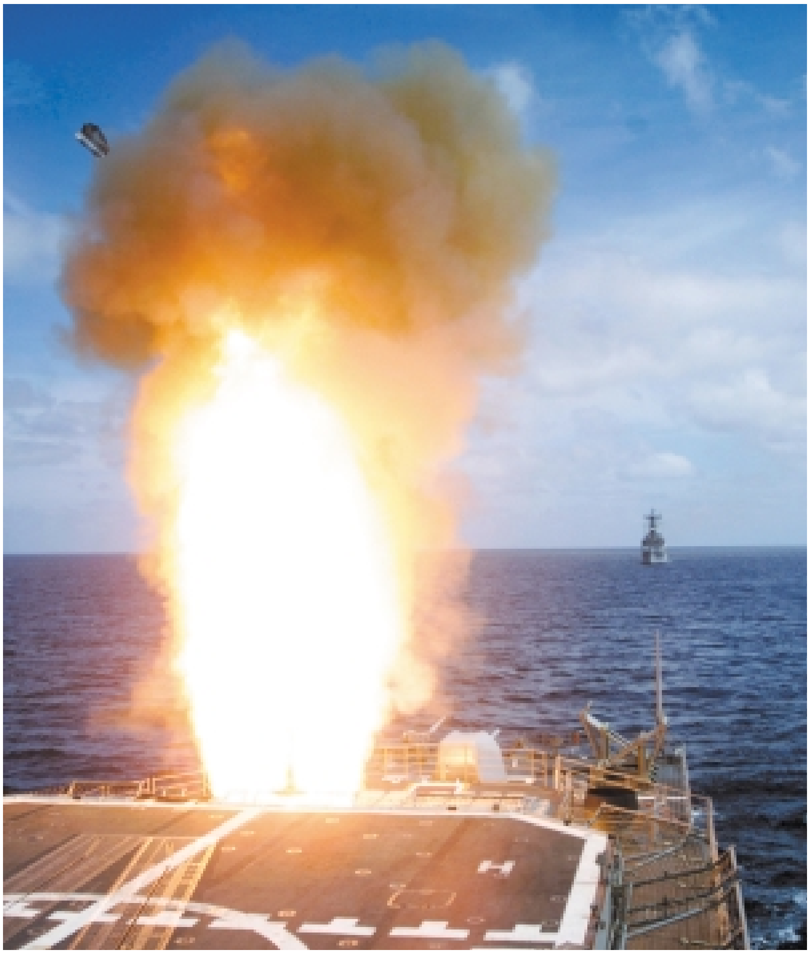
The TAMD vision introduces six basic tenets that combine to describe capabilities needed to achieve the desired outcome of the mission area. The tenets are enabling conditions for *preventing*, *defeating*, and *minimizing* activities in the mission area and suggest a pathway to interoperability which starts with increasing situational awareness in the battlespace and extending multi-sensor integration capabilities for earlier information on prospective targets. This pathway continues by improving sensor ranges to obtain additional battlespace and optimizing the overall probability of destroying attackers with increased engagement opportunities. The conditions that prevent, defeat, and minimize outcomes require increased interoperability between existing systems and an open, integrated architectural approach for emerging capabilities.

Prevent, Defeat, Minimize

The tenet identified with preventing, attack operations, is designed to stop air threats prior to launch. Debate over the relative contribution of attack operations to the TAMD mission area is ongoing and touches sensitivities related to service roles and missions, asset allocation, and control. This article does not attempt to influence the debate except to indicate that future TAMD operations rely on the major role that attack operations must play in reducing a threat set to manageable levels. Emerging joint doctrine asserts that attacking to destroy or disrupt theater missiles prior to launch is the preferred method of countering enemy theater ballistic missile operations. A similar approach can be advanced with regard to cruise missile and manned aircraft threats.

The next four tenets of the vision primarily concern the defeat aspect of the TAMD mission area and represent functions that support active defense measures against in-flight air and missile threats. Primary among the active defense tenets discussed in the vision is the need for a complete, common, and accurate picture of the air battlespace that permits everyone involved to perceive and understand the situation in the same way. This picture, developed by integrating capabilities and data from systems throughout the battlefield, produces only one track for each airborne object as opposed to multiple tracks produced by current systems. This single integrated air picture (SIAP) provides commanders with a view of the battlespace which has sufficient quality to vastly improve the accuracy and timeliness of coordination and operational decisions. SIAP increases the chances of successfully engaging threats by providing a better picture to key operators than can be achieved through organic systems alone by supporting joint and overlapping weapon engagement zones and by offering multiple engagement opportunities and options to commanders.

SIAP enhances the defense of a broad area with mutually supporting joint and interoperable forces. It creates conditions to attain self-synchronization among air and missile defense elements. These elements of self-synchronization—robust, networked entities sharing awareness information and a rule set to operate interactively—reduce the demands for different elements to regenerate and retransmit location information as well as other data. Self-synchronization links go a step beyond situational awareness to a point where weapons and sensors receive information on the respective status of every element (such as available missiles, fuel on board, system operating parameters, targeting information, and tracking data) in sufficient detail for the control components to identify which sensor is best positioned to track targets or control fires, and which weapon can



U.S. Navy (Ty Swartz)

USS Hewitt **firing SM–2 anti-missile rockets.**

best shoot at a target. The effects of SIAP combine to increase the ability of commanders to rapidly shift air and missile defense resources and focus effects on an enemy.

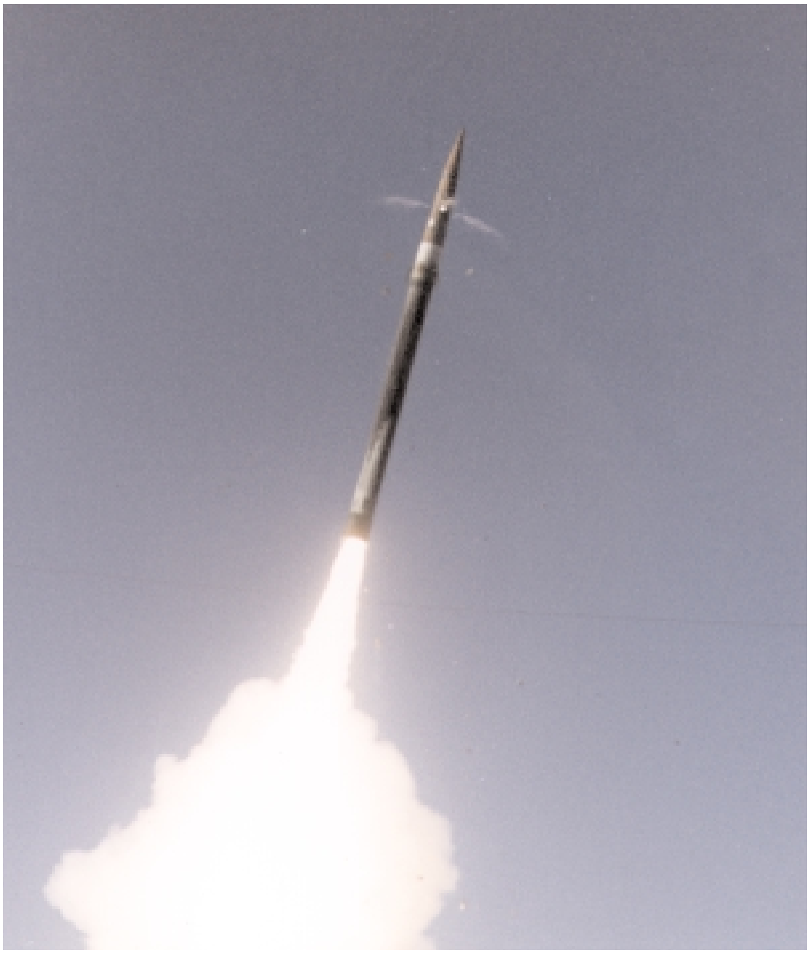
The next tenet is long range, wide area combat identification. Airborne objects within the battlespace must be detected early to enable the multiple engagement opportunities needed for high confidence, full dimensional protection. Defense in depth depends on opportunities to engage and defeat incoming air threats. Building on SIAP, wide area combat identification maintains relevant information, establishes a single identification for each object, and merges data collected from both identification and track sources to build integrated track information. Reliable identification linked to SIAP enables the release of defensive weapons with the confidence that friendly forces will not be hit and increases the engagement options available. Effective wide area combat identification is key to reducing the complexity of the battle picture and helping to distinguish between friendly and hostile aircraft, enemy cruise missiles, and other objects of interest within a commander's areas of responsibility. This aspect of the vision addresses the types of shortcomings that contributed to the *USS Vincennes* and Blackhawk incidents.

commanders need tools to take advantage of the extended battlespace made available by integrated fire control

Integrated Fire Control

Admiral William Owens, the former Vice Chairman, suggested that connecting fire control radar from a land-based system with missiles from a sea-based system might provide capabilities which exceed either system. The integrated fire control described in the TAMD vision extends the case for synergy between systems by focusing on making the best use of available air and missile defense assets. For example, fusing target information from various sensors potentially improves the quality of target data and may permit the destruction of targets beyond the range of constraints imposed by organic surveillance radar. A realistic, technically attainable result of an integrated fire control approach is launching a weapon with information obtained from a remote sensor (perhaps including advanced sensor technologies for precision tracking and terminal guidance data) against targets the weapon would not normally be able to detect or engage. The vision postulates several benefits of integrated fire control that include overcoming horizon limitations imposed by terrain and the curvature of the earth, reclaiming battlespace by increasing the size of defended areas, and improving defense in depth. Integrated fire control seeks to overcome the limitations of individual systems by employing the strengths of all surveillance, fire control, and weapons capabilities.

The fifth tenet is automated battle management aids. It is derived from the challenges posed by the management of widely dispersed, highly technical assets over extended geographical areas. Greatly expanded air and missile defense resources on a joint battlespace require selecting a proper mix of assets quickly and accurately, and exercising effective control in a dynamic environment. Commanders need tools to take advantage of the extended battlespace made available by SIAP, earlier combat identification, and integrated fire control. Automated battle management aids require common algorithms and inputs, detailed information about system members, and a means to codify options to ensure consistency and quality of decision support information. Such tools will reduce complexity to manage available TAMD resources.



THAAD FTV–03 at White Sands Missile Range.

The last tenet represents a subset of the large, extensive functional area of passive defense. Obviously, theater air and missile defense is not the only purview of passive defense. The vision is focused on an element of passive defense, improved early warning, that offers a discrete, TAMD relevant portion of the overall function. Early warning and other elements of passive defense that must be eventually addressed develop in the minimize component of the mission area. Warning also involves predicting impact points and times to prompt active defense systems on anticipating intercepts and to enable forces to optimize passive defense measures. One goal of early warning is to avoid reducing the operational effectiveness of friendly forces in areas unaffected by missiles.

A Joint Perspective

Several steps must be taken in order for TAMD to become a reality. The JTAMD process must identify architectural alternatives for requisite capabilities. Costs associated with developing and fielding such capabilities must be identified with as much precision as possible. Recognizing fiscal realities, the process must prioritize capabilities to implement basic elements of the vision. Despite evidence that air and missile defense architecture has not yet achieved the requisite interoperability, no program or funding source exists specifically to create interoperability in TAMD systems and organizations. The JTAMD process must lead decisionmakers to make investment decisions which will implement appropriate capabilities.

JTAMDO is leading the first comprehensive assessment of a warfighting mission area from the perspective of a joint, interoperable class of systems. This mission area assessment will offer a common picture of the theater air and missile defense, identify metrics for warfighting, and furnish an investment strategy for solving challenges associated with implementing the JTAMD vision.

BMDO and JTAMDO are forging a long range master plan to articulate joint requirements for interoperability, designing a class of systems architecture to meet the requirements, and laying out an acquisition strategy to make the architecture a reality. This TAMD master plan relies heavily on the active participation of the joint warfighting community. Eventually the acquisition road map will provide an incremental approach to implementing integrated, interoperable TAMD capability.

Capstone documentation on operational requirements prepared by U.S. Atlantic Command which has now been redesignated U.S. Joint Forces Command—considered TAMD from a position of joint interoperability. This series of documents includes a joint mission needs statement, capstone requirements document, and future documents applicable to TAMD systems. The documents represent a basic new approach to communicating requirements for theater air and missile defense to the development communities, and they will have a significant impact on future systems requirements documents.

The path toward air and missile defense interoperability undertaken by JTAMDO, BMDO, JFCOM, and other members of the military establishment conforms with the Nation's approach to defense. The information centric vision leverages America's lead in information technologies to minimize casualties and meet the goals outlined in *Joint Vision 2010*. The TAMD vision for 2010 outlines an attainable architecture that protects forces from theater air and missile threats. The architecture offers commanders the flexibility to operate effectively in the dynamic battlespace of the future, makes the best use of technological advantages, and pushes warfighting capabilities well ahead of any potential enemy. JFQ